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“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

CODE OF PRACTICE FOR
SETTING OUT OF BUILDINGS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

CODE OF PRACTICE FOR SETTING OUT OF BUILDINGS

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Indian Standard

CODE OF PRACTICE FOR SETTING OUT OF BUILDINGS

0. FOREWORD

0.1 This Indian Standard was adopted by Indian Standard Institution on 28 June 1984 after the draft finalized by the Building Construction Practices Committee had been approved by the Civil Engineering Division Council.

0.2 The setting out of building may be compared with the procedure for measuring topographic details for general mapping purposes. The purpose of setting out is to indicate the position of proposed features. This may be contrasted with the purpose of land surveying which is to determine the position of existing features (topography or cadastral surveying). Such a survey is based on a number of previous measuring operations according to a general procedure. Starting from first order triangulation points, the point to be located is usually reached after a long series of measuring operations (secondary and other lower order

triangulation nets, polygons, etc). This standard applies to all usual types of building construction. Specialist operations, such as setting out of precision machinery, require individual treatment.

0.3 This standard is based on ISO 4463-1979 'Measurement methods for building-setting out and measurement — Permissible measuring deviations' published by International Organization for Standardisation (ISO).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2 - 1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard deals with the different stages of the setting out work, that is, the measuring of the primary framework (traverses, grids, etc) on the site, the setting out of reference lines (baselines), the transfer (plumbing up) of reference lines to other floors, the setting out of position points and the levelling procedure for these different stages. It gives values for permissible deviations when measuring and setting out and recommends certain procedures and instruments to be used. Guidance is given on how inaccuracies can be controlled during the setting out process when using instruments and methods which are currently in common use in building construction.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Primary Point — The point which has been established by measurement. Primary points are referred to the national, municipal or other agreed reference systems and constitute the reference points for setting out the secondary points. These may have been adjusted locally.

2.2 Secondary Point — The point which, on its own or in combination to form lines, constitutes a reference point for the setting out of position points. A structural grid may be constituted from a system of secondary points.

2.3 Position Point — The point which marks the position of a certain detail of a building.

2.4 Grid — Two sets of parallel horizontal lines which are at right angles to each other.

2.5 Primary Bench Mark — Bench mark which has been established by levelling. Primary bench marks are referred to the national, municipal or other agreed reference system and constitute the reference levels for the establishment of secondary bench marks. These may have been adjusted locally.

2.6 Secondary Bench Mark — Transferred bench mark established by levelling, which constitutes the reference level for setting out the position levels.

2.7 Position Level — The point which marks the level of a certain detail of a building.

2.8 Check Measurement — Independent measurement to check the correctness and accuracy of a previous measurement.

2.9 Anblock Method — Adjustment method by which adjacent local system of measuring points, for example those determined by the polar measuring method from a number of instrument stations, are connected together in one co-ordinate system (a block).

NOTE—This method allows the number of necessary instrument stations to be reduced (see Fig. 3 and 5).

2.10 Discrepancy — Difference between the measured and calculated values of point with given co-ordinates (for example, between the points 10 and 320 in Fig. 3 and 5).

2.11 Deviation — The deviations in this Indian standard refer to the difference between the determined values of the distance, angles and levels and their given or calculated values (see Fig. 1).

2.12 Permissible Deviation (E) — Specified limit of deviation.

In this Indian standard, the permissible deviations for given or calculated distances, angles and levels (vertical distances) are specified. It is assumed that permissible deviations are both positive and negative and of equal numerical value (see Fig. 2).

3. PRINCIPLES OF SETTING OUT

3.1 The setting out process can be controlled by dividing it into four stages. Figure 3 gives an example of the general principles.

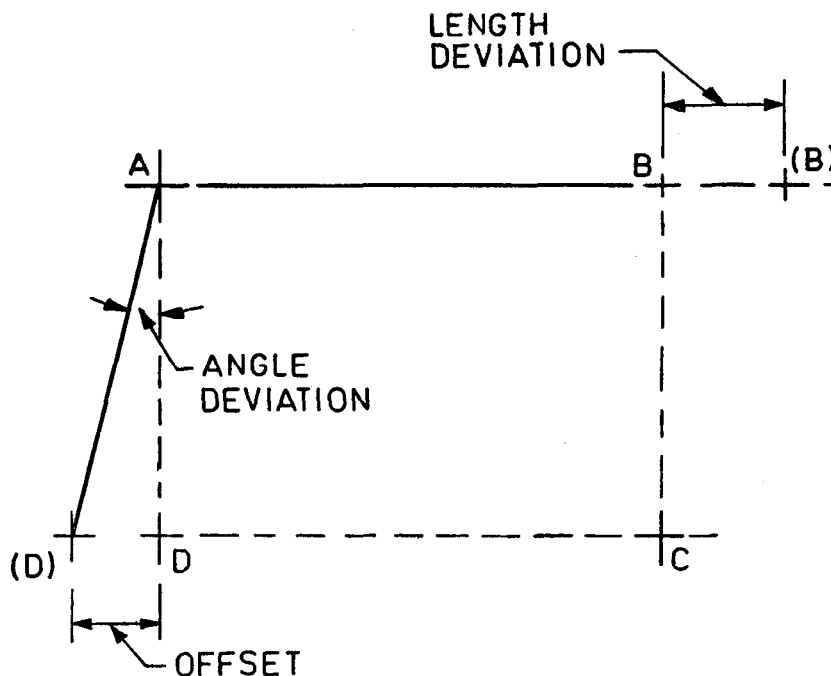
Most setting out begins at one or more points in the national, municipal or other

agreed co-ordinate system. For large projects, it is often necessary to set up a local traverse or a network of triangles containing primary points. From these primary points, the secondary points (points on base lines) can be established by means of intersection, resection, polar method, etc. Finally, the locations of columns, walls, etc (position points) are determined from the secondary system.

Setting out small projects will usually commence with the secondary system or even position points. This can also be the case when the setting out has to be related to grids on the building site (see 9).

As emphasized above, the accuracy of setting out should not be influenced by discrepancies in the surrounding official reference points. It may therefore be necessary to make the adjustment of the measurement values within the primary system, that is, as a free net, and not in relation to the points of the surrounding official reference system. In such cases, primary systems are only connected to the national, municipal or other agreed co-ordinate system.

This standard also gives guidance on this aspect of setting out and recommends that the establishment of primary systems should be entrusted to personnel with relevant professional qualifications, as the accuracy of primary points depends not only on the accuracy of the measuring operations but also on the configuration of the primary system. For the setting out



A, B, C and D are given or calculated positions of points
(B) and (D) are determined positions of points B and D respectively

FIG. 1 INTERNAL ACCURACIES OF SETTING OUT ARE CHECKED BY MEASURING ANGLES AND LENGTHS

of the secondary and lower order systems, an engineer or surveyor with detailed knowledge of building survey techniques should be engaged. The setting out of position points can usually be carried out by a foreman on the site.

Generally the connection of primary systems to the official co-ordinate system has to be carried out in consultation with the survey department of the local authority.

The accuracy requirements in this standard are expressed by permissible deviations (E) for lengths, angles and levels, obtained as a result of measuring operations (see Fig. 2).

4. MEASUREMENT

4.1 Distance Measurement — Measuring tape conforming to IS : 1269-1964* shall be used for distance measurement. The values measured shall be corrected for temperature, sag, slope and tension. A tension device is to be used with the tape. In case of check measurement a different measuring tape but conforming to IS : 1269-1964* shall be used.

4.2 Angles Measurement — Angles shall be measured with theodolite with accuracy of 20 seconds and 1 minute for primary system and secondary system respectively. The measurement shall be made in at least one set. A set is formed by two observations, one on each face of instrument. For check measurement another instrument of same accuracy should be used if possible.

5. LIMITATIONS

5.1 As all these measuring operations are subject to inaccuracies, the accuracy of the determined position of a certain point generally decreases in proportion to the number of operations according to the law of propagation

of errors (see Fig. 4). For all measuring work, it is therefore very important to keep the number of operation, as small as possible. For general topographic or cadstral surveys (see Fig. 4), the accuracies obtained (mean standard errors between 5 and 30 mm) are usually sufficient, but they cannot be accepted for most technical work, for example, precision setting out and deformation measurements. When setting out buildings, the accuracy requirements have to be related to internal accuracies (that is between points A, B, C and D in Fig. 3 and 4). The accuracy of setting out within a building is more critical than the accuracy of the location of a point, for example out of the national co-ordinate system. Using different polygons for the setting out of the main points of a building (corner points or base lines as in Fig. 4) can lead to inaccuracies between the main points. This is because these polygons are often part of a measuring series with different grade of accuracy.

Corner and base line points must be set out so as to limit inaccuracies. It is from these that the building elements and components, such as walls and columns, are located. If this is disregarded, serious practical problems are likely to arise during the erection of the building. For example, windows or other components may not fit between columns. It is essential therefore that the setting out is carefully controlled throughout.

6. ESTABLISHMENT OF PRIMARY POINTS

6.1 Introduction — This clause specifies the accuracy requirements with regard to the relative position of primary points and applies to building projects where the primary points constitute the reference points for the placing of buildings and parts thereof.

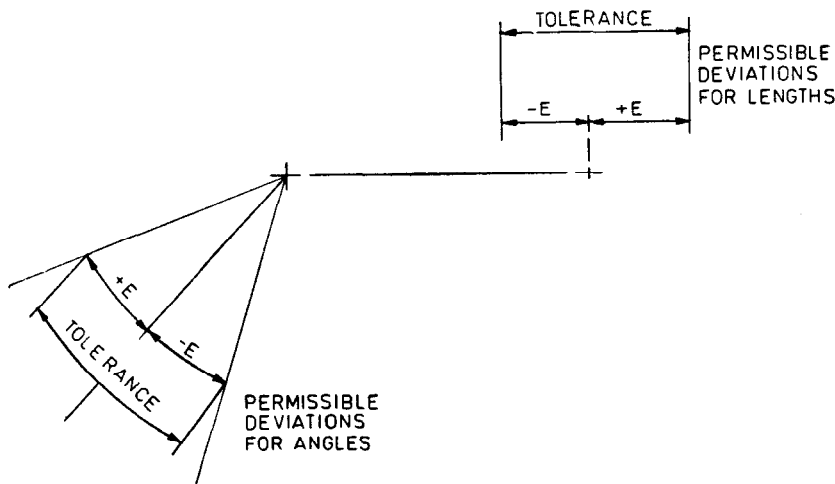
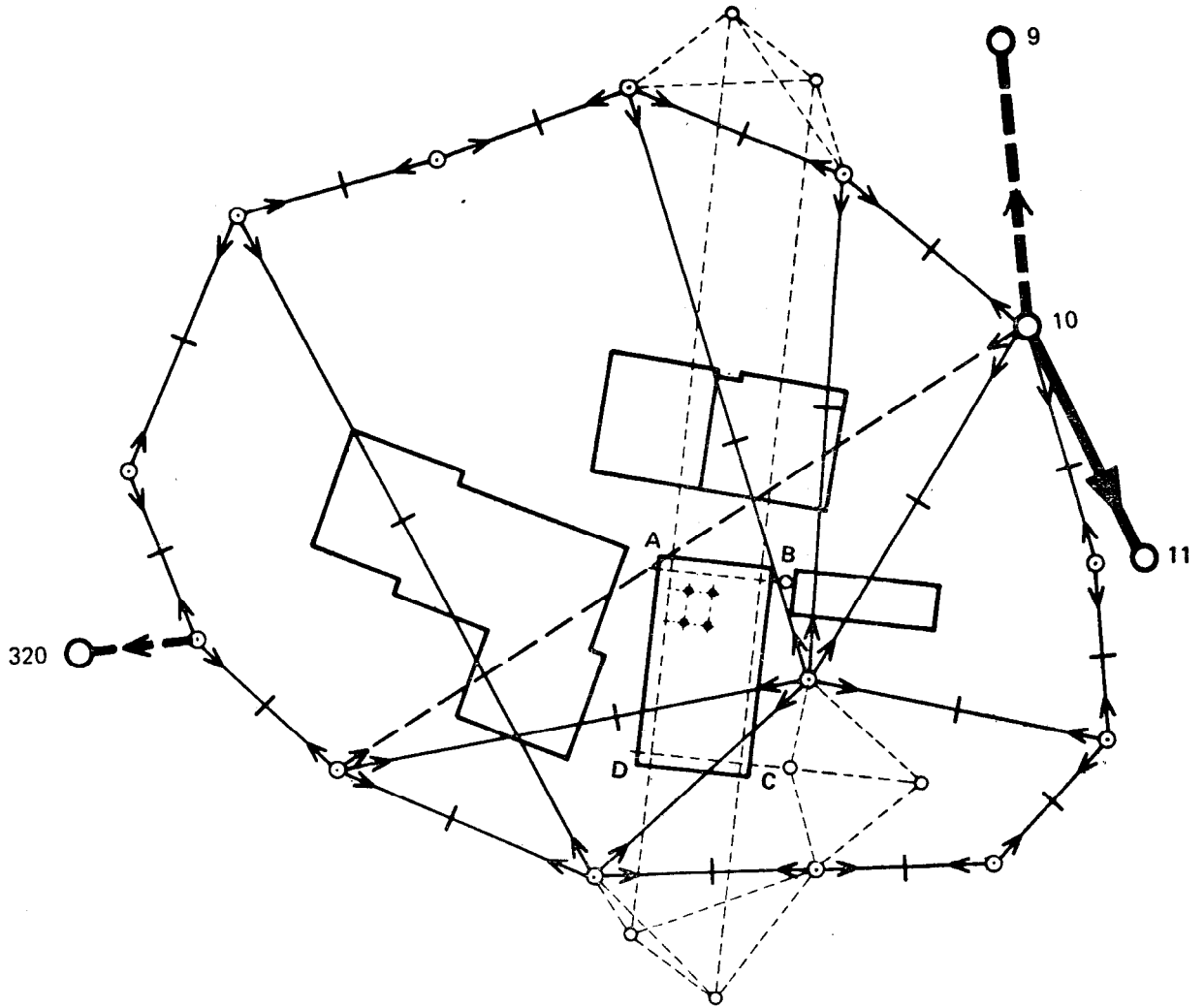


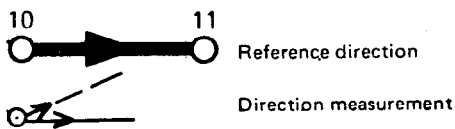
FIG. 2 THE PERMISSIBLE DEVIATIONS EXPRESS THE ACCURACY REQUIREMENTS AS SHOWN

*Specification for metric, woven metallic and glass fibre tape measure (revised).

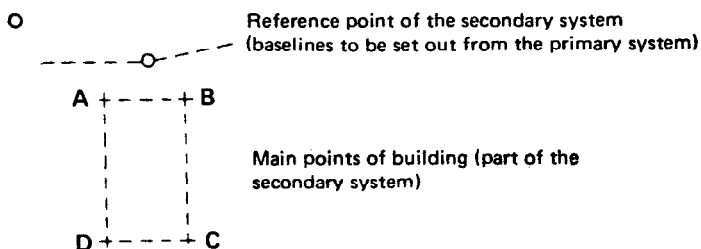


A free net. Co-ordinates of the primary points are determined from a network of traverses.

- Reference point of the national, municipal or other agreed system
- Reference point of the primary system



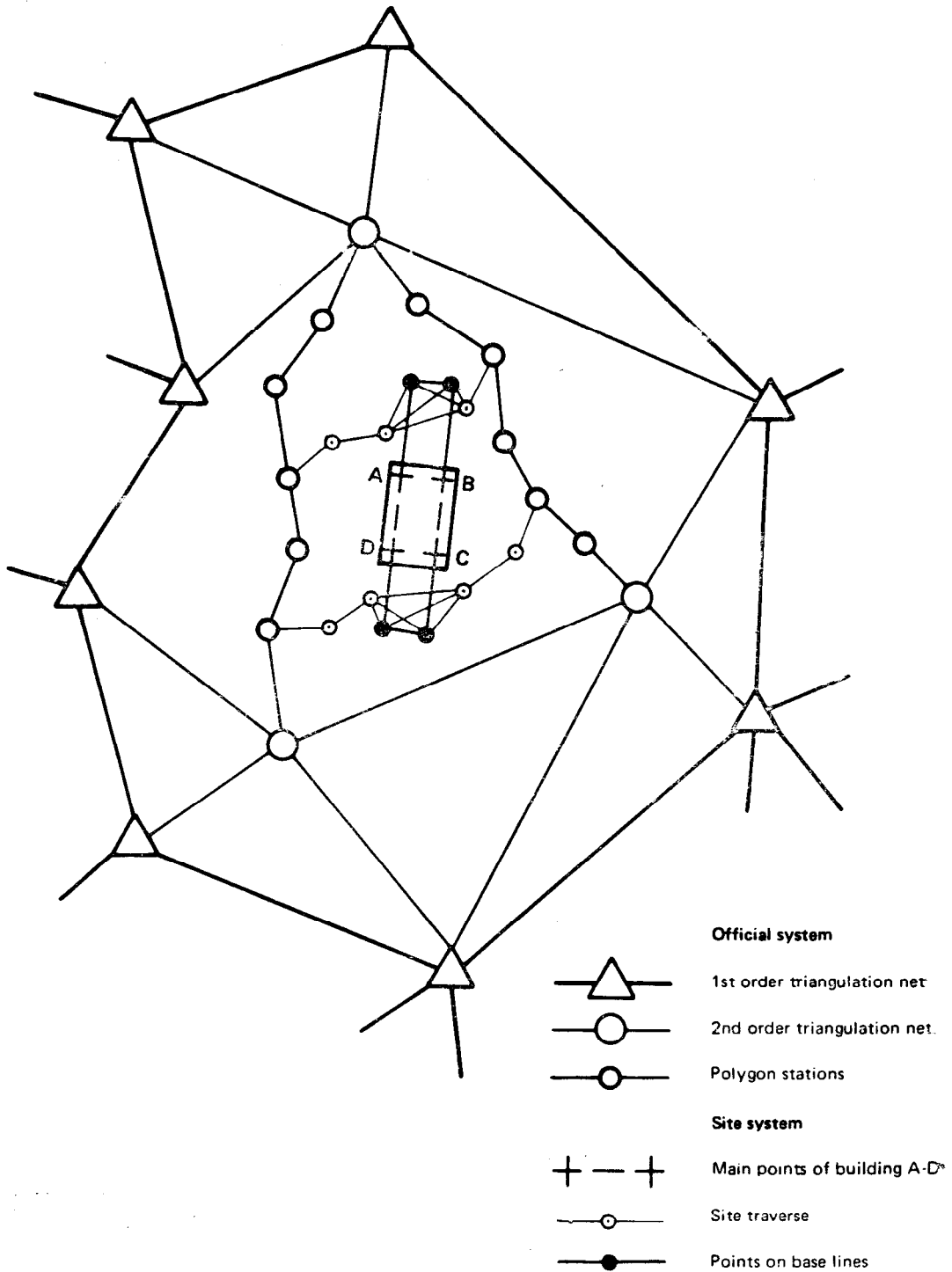
- 10 Reference point
- ———> ○ Length measurement
- > Position check, not to be used in the adjustment



- ◆ Position points (for example centre lines for columns)

NOTE — This free net is connected to the official co-ordinate system by one reference point (10) and one reference direction (10-11). This implies that the accuracies of the main points are not influenced by existing inaccuracies of the points in the national, municipal or other agreed reference system.

FIG. 3 EXAMPLE OF SETTING OUT RELATED TO A FREE NET



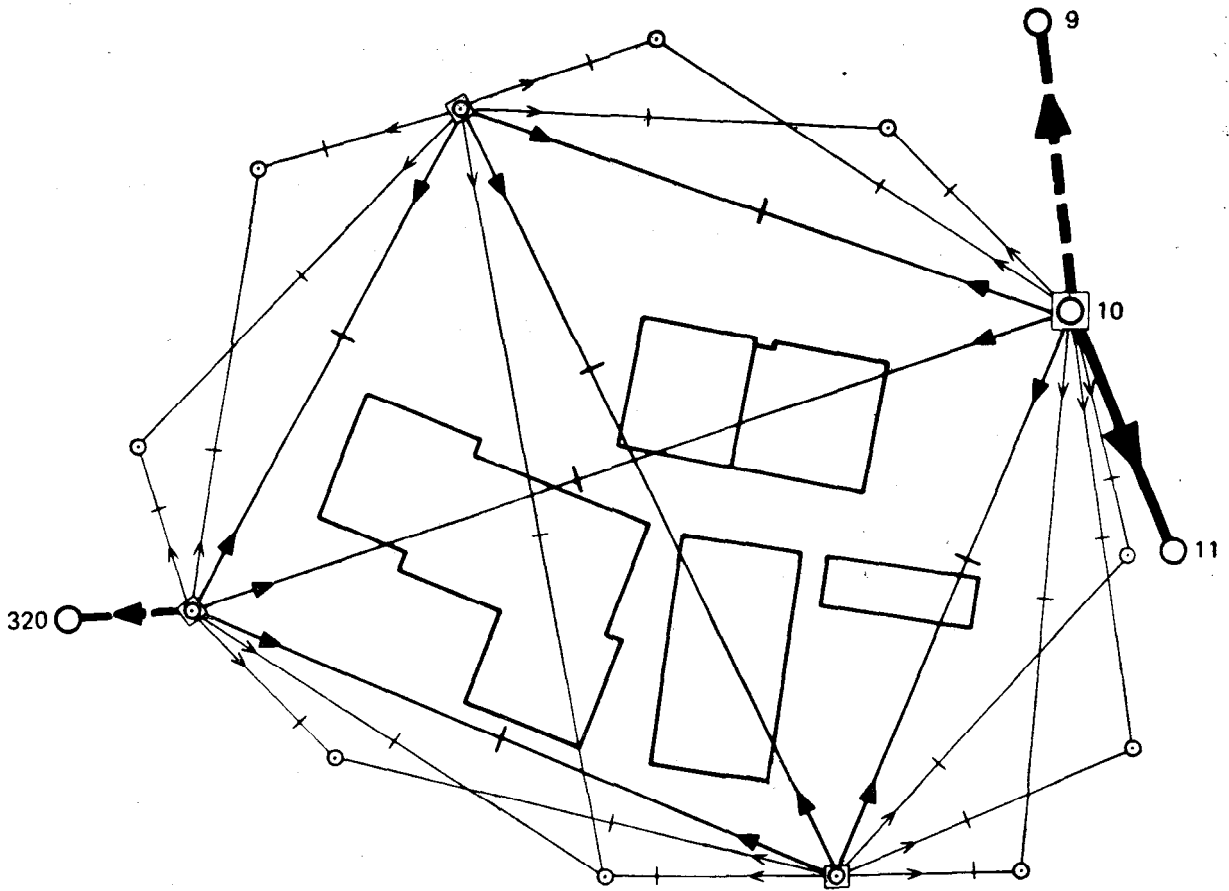
NOTE — This procedure is not recommended (see 6.2).

FIG. 4 EXAMPLE OF SETTING OUT RELATED TO DIFFERENT REFERENCE POINTS IN THE SURROUNDING OFFICIAL CO-ORDINATE SYSTEM

6.2 Primary System — Wherever possible, primary points shall, while being established, make up a framework which can be calculated and adjusted in its entirety. Points which cannot be formed by simultaneous adjustment into a framework may be determined from loop traverses (see Fig. 3), by means of redundant resection, intersection, simultaneous polar method, anblock method (see Fig. 5) or

any similar method. All the primary points of a building site constitute the primary system.

As the accuracy of the main points, for example, *A, B, C,* and *D* of the building is likely to be influenced by inaccuracies in the official system, the principle of connecting the site system to the official system by more than one reference point is not generally recommended.



A free net. Co-ordinates of the primary points are determined by measuring lengths and directions.

○ Reference point of the national, municipal or other agreed system

⊙ Reference point of the primary system



Reference point and instrument station



Reference direction



Instrument station



Length and direction measurement from instrument station



Double measurement



Position check, not to be used in the adjustment

NOTE — The adjustment of the primary system has to be done in its entirety, according to the method of least squares. With the "anblock" method, the entire primary system is determined from only a few instrument stations.

FIG. 5 EXAMPLE OF "ANBLOCK" METHOD FOR MEASURING A FREE NET
(TO BE COMPARED WITH FIG. 3)

6.3 Connection to Existing Systems — Information regarding suitable points in an official survey system which the primary points can be connected is to be obtained from the appropriate authority. As far as possible their position should be checked.

Any discrepancies in connecting the primary system to the official system are not normally adjusted in the primary system. They are not to be adjusted if this causes the relative positions of the primary points to be altered in such a way that the accuracy requirement of the position of points, specified in this Indian standard, is exceeded.

6.4 Permissible Deviations of the Position of a Primary Point — The accuracy of the position of a primary point may be assessed according to 6.4.1 or 6.4.2.

6.4.1 Measured and Calculated Values — The permissible deviations of the distances and angles obtained while measuring the positions of primary points, and those calculated from the adjusted coordinates of these points shall not exceed the following:

$$\begin{aligned} \text{Distances } &\pm 0.75\sqrt{L} \\ \text{Angles } &\pm 0.045/\sqrt{L} \\ &\text{or } \pm 0.05/\sqrt{L} \text{ gon}^1 \\ \text{offset: } & (= 0.8\sqrt{L} \text{ mm}) \text{ (see Fig. 1)} \end{aligned}$$

where:

L = the distance in metres between the primary points concerned; in the case of angles, the shorter distance.

$$1 \text{ gon} = 0.9 \text{ degree.}$$

6.4.2 Checked and Calculated Values — The permissible deviations of the distance and angles obtained while checking the positions of primary points, and those calculated from the adjusted co-ordinates of the points, shall not exceed the following:

$$\begin{aligned} \text{Distances } &\pm 2\sqrt{L} \text{ (mm)} \\ \text{Angles } &\pm 0.135/\sqrt{L} \text{ degree} \\ &\text{or } \pm 0.15/\sqrt{L} \text{ gon} \\ \text{offset: } & (= 2.4\sqrt{L} \text{ mm}) \text{ (see Fig. 1)} \end{aligned}$$

where:

L = the distance in metres between the primary points concerned, in the case of angles, the shorter distance.

6.5 Marking — Primary points shall be marked so that any displacement in their positions, due to external action, frost movement, etc, is

prevented as far as possible. Primary points are to be indicated by precise marking, for example, by punch marks. Whenever possible, primary points should be placed outside the actual working zone on the site.

6.6 Errors — Discrepancies in primary systems on building sites are often the result of centering errors during the measuring operations.

Centering errors are caused by:

- a) Instrument errors (optical plummets in theodolites and targets and 'constrained or forced centering' should be checked regularly; and
- b) Badly defined points, for example, rough marks, excessive diameters.

7. SETTING OUT OF SECONDARY POINTS

7.1 Introduction — This clause specifies the accuracy requirements with regard to the relative positions of points in the same secondary system, between points in different secondary systems and between primary points (according to 6) and secondary points.

7.2 Secondary System — Secondary points constitute the reference points for setting out details of one or more buildings — unless a detail is set out directly from the primary points. Secondary points may be combined two-by-two to form base lines for detailed setting out. Secondary points can also be chosen as points of a site grid (see 9).

All the secondary points and the main points (see Fig. 3) of a building taken together from a secondary system.

7.3 Permissible Deviations of the Position of a Secondary Point

7.3.1 In Relation to a Primary Point — The permissible deviation for a checked distance from a given or calculated distance between a primary point and a secondary point shall not exceed $\pm 2\sqrt{L}$ (mm), where L is the distance in metres.

7.3.2 Between Points in the Same Secondary System — The permissible deviations for a checked distance from the given or calculated distance between two secondary points in the same secondary system shall not exceed $\pm 2\sqrt{L}$ (mm), where L is the distance in metres.

For L less than 10 m, the permissible deviations are ± 6 mm.

The permissible deviations for a checked angle from the given or calculated angle between two lines in the same secondary system shall not exceed $\pm 0.135/\sqrt{L}$ degree ($\pm 0.15/\sqrt{L}$ gon), where L is the length in metres of the shorter side of the angle.

7.3.3 Between Points in Different Secondary System — The permissible deviations for a checked distance from the given or calculated distance between two points in different secondary systems for the same building project should not exceed $\pm K\sqrt{L}$ (mm), where L is the distance in metres and K is a constant according to the accuracy requirements as given in 8.

8. SETTING OUT OF POSITION POINTS

8.1 Introduction — This clause specifies the accuracy requirements of the relative positions of position points.

8.2 Permissible Deviations of a Position Point — The permissible deviations of a checked distance between a secondary point and a position point, or between two position points are $\pm K\sqrt{L}$ (mm), where L is the specified distance in metres and K is a constant according to Table 1.

For L less than 5 m, the permissible deviation is $\pm 2K$ (mm).

The permissible deviations for a checked angle between two lines, dependent upon each other, through adjacent position points are $\pm 0.067 K/\sqrt{L}$ ($\pm 0.075 K/\sqrt{L}$ gon), where L is the length in metres of the shorter side of the angle and K is a constant as given below:

K	Examples of Application
10	Earthwork without any particular accuracy requirement, for example, rough excavation, revetments, etc.
5	Earthwork subject to accuracy requirements, for example, road works, pipe trenches, bases, etc.
2	<i>In-situ</i> cast concrete structures, kerbs, etc.
1	Precast concrete structures, steel structures, etc.

Where the accuracy requirements for setting out are different from these stated above, they shall be specified in the contract documents.

8.3 Setting out — Setting out for values of K of 5 or less shall be carried out according to 4.1 and 4.2.

9. GRIDS (see 2.4)

Some of the different grids are as follows:

- On sites with a large number of parallel building lines, the setting out work can often be simplified by choosing the secondary system (see 7) such that a grid known as a site grid is formed.
- The centre lines of structural elements of a building, which together form the structural grid, are normally established with reference to base lines. The purpose of this grid is to locate the position of the structural elements of the building (see Fig. 6).

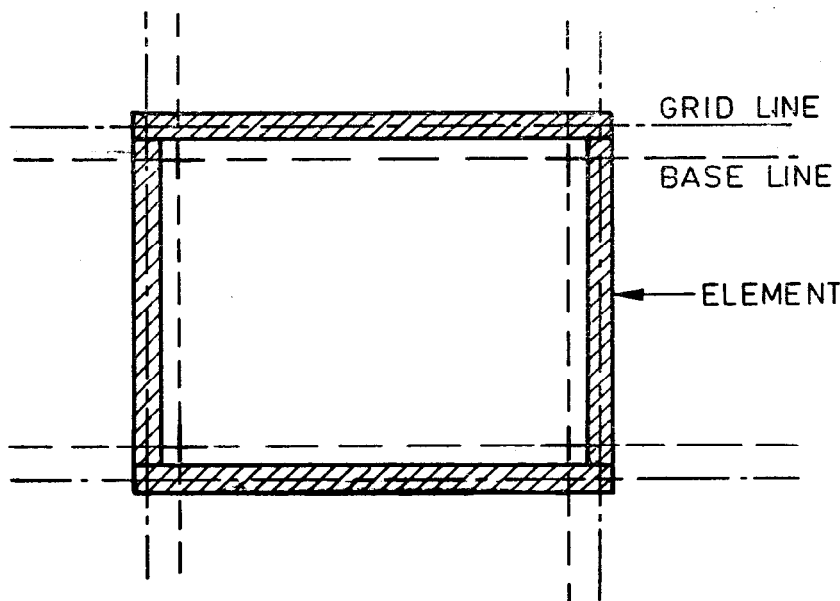


FIG. 6 LOCATION OF THE POSITION OF THE STRUCTURAL ELEMENTS

- c) Planning authorities often make use of a system of reference lines, for example, location grids, to divide large built-up areas or development schemes into smaller sections. The main function of such a reference system is to indicate the legal position (specified in planning laws or local regulations) of boundaries of properties, buildings, axes of streets, kerbs, manholes, etc, in the area in question.

Reference systems (after they have been established within the site) are therefore mostly regarded as error free. The accuracy requirements are given by national laws or other regulations and are often designed only in order to avoid disputes.

This may imply, for example, that a location grid is not always considered as a secondary system in the sense of this Indian standard. In such a case, where requirements have to be ensured on both critical legal measurements from grid lines and internal accuracies, the following general method can be applied:

For each square of the location grid, the setting out is related to one grid station as a reference point, and to one grid line as a reference direction (see Fig. 7). This procedure, however, is the most general one, as objects

other than buildings may influence the choice of a suitable procedure. It is therefore very important that the appropriate authority is consulted before the setting out work takes place. Where accuracies of a location grid do not fulfil the requirements in this Indian standard, the internal accuracy of the building system can be ensured by relating the setting out to one reference point and one reference direction.

Before choosing suitable points and directions, the appropriate authority is to be consulted.

10. VERTICAL TRANSFER OF MAIN POINTS (SECONDARY REFERENCE POINTS) TO OTHER LEVELS — VERTICALITY DEVIATION (PLUMBLINE DEVIATION)

10.1 Introduction — This clause specifies the accuracy requirements for the relative position of transferred main points of buildings to other levels. The deviation of the transferred point (the verticality deviation) is the horizontal distance between the transferred point and the vertical line through the corresponding main point of the building (see Fig. 8). (see also 11 which gives information on distances between levels).

10.2 Permissible Deviations of the Position of Transferred Point — The permissible verticality deviations of the checked.

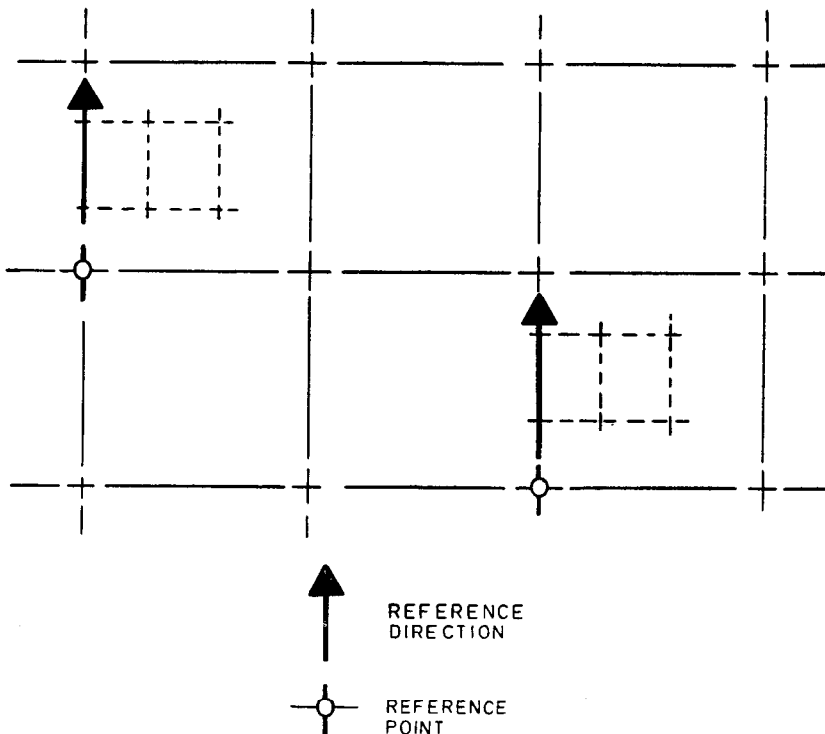


FIG. 7 LOCATION GRID USED AS A REFERENCE SYSTEM TO INDICATE THE POSITION OF STRUCTURES ACCORDING TO LEGAL BUILDING REQUIREMENTS

transferred points are $\pm 2\sqrt{L}$ (mm), where L is the vertical distance in metres between the main point and the transferred point (see Fig. 8).

For L less than 5 m, the permissible deviations are ± 4 mm (see also 7).

10.3 Plumbing — Plumbing shall be carried out either with an optical plumbing instrument or a theodolite and, if possible, from the same secondary reference point.

When plumbing with a theodolite which is set up away from the point to be transferred, it is necessary to take observations on both faces of the instrument and to use the mean value.

When an optical plumbing instrument or a theodolite with the telescope pointing vertically is used, at least for observations are to be made at 100 gon (90°) to each other on the horizontal circle.

10.4 Marking — A transferred point should, immediately after the measuring operation be marked so as to prevent displacement in its position.

10.5 Check Measurements — Optical plumbing operations shall be checked with an instrument with at least the same measuring accuracy as in 10.3.

10.6 Safety — Upward plumbing through sighting holes can give rise to safety risks.

11. LEVELLING OF PRIMARY AND SECONDARY BENCH MARKS AND POSITION LEVELS

11.1 Introduction — This clause specifies the accuracy requirements with regard to the relative positions of the levels of primary bench

marks, secondary bench marks and position levels.

11.2 Permissible Deviations of the Difference in Level

11.2.1 Primary and Secondary Bench Marks — When checking the difference in level between two bench marks, against the specified or calculated difference in level, the permissible deviations are as follows:

- a) ± 10 mm in the case of a bench mark in an official system and a primary bench mark. Information regarding a suitable bench mark for use as the reference level in the setting out system should be obtained from the appropriate authority;
- b) ± 5 mm in the case of any two primary bench marks in the same primary system;
- c) ± 5 mm in the case of levels transferred from a primary to a secondary bench mark;
- d) ± 3 mm in the case of any two secondary bench marks in the same system, if the difference in level does not exceed 3 m;
- e) ± 1 mm/m of difference in level in the case of any two secondary bench marks in the same system, if the difference in level is greater than 3 m.

Where the accuracy requirements for setting out are different from those stated above, they shall be specified in the contract documents.

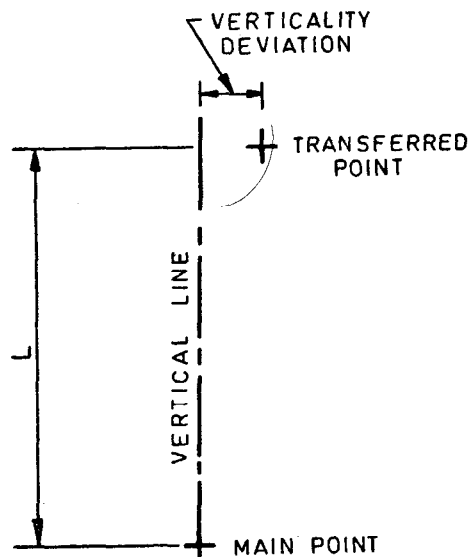


FIG. 8 VERTICALITY DEVIATION (PLUMBLINE DEVIATION)

11.2.2 Secondary Bench Marks and Position Levels — The permissible deviations for a checked difference in level between secondary bench marks and position levels or between arbitrary fixed position levels, are as given below:

11.3 Setting out, Levelling and Check Levelling — Before an instrument is used for first time, it is to be checked thoroughly for accuracy and stability, and adjusted if necessary. Thereafter it should be re-checked frequently.

<i>Permissible Deviation mm</i>	<i>Examples of Application</i>
± 30	Earthwork without any particular accuracy requirements, for example, rough excavation, revetments, etc.
± 12	Earthwork subject to accuracy requirements, for example, road works, pipe trenches, etc.
± 5	<i>In-situ</i> cast concrete structures, kerbs, etc.
± 2	Precast concrete structures, steel structures, etc.
